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Disasters and Social Resilience

A bioecological approach

Helen J. Boon, Alison Cottrell and David King

ROUTLEDGE

Disasters and Social Resilience

The interconnectedness of communities, organisations, governing bodies, policy and individuals in the field of disaster studies has never been accurately examined or comprehensively modelled. This kind of study is vital for planning policy and emergency responses and assessing individual and community vulnerability, resilience and sustainability as well as mitigation and adaptation to climate change impacts; it therefore deserves attention.

Disasters and Social Resilience fills this gap by introducing to the field of disaster studies a fresh methodology and a model for examining and measuring impacts and responses to disasters. Urie Bronfenbrenner's bioecological systems theory, which looks at communities holistically, is outlined and illustrated through a series of chapters, guiding the reader from the theory's underpinnings through research illustrations and applications focused on each level of Bronfenbrenner's ecosystems, culminating in an integration chapter. The final chapter provides policy recommendations for local and national government bodies and emergency providers to help individuals and communities prepare and withstand the effects of a range of disasters.

This book will be of great interest to scholars and students of disaster and emergency management, disaster readiness and risk reduction (DRR), as well as more general climate change and sustainability studies.

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1 Introduction

Helen J. Boon

Bronfenbrenner's bioecological systems theory and climate change

This book is intended to outline and describe a method for estimating social resilience to disasters based on Uri Bronfenbrenner's bioecological systems theory. The need to estimate and measure resilience to disasters is a consequence of global climate change effects which have led to an increase in natural hazards. Governments worldwide have recognised that an effective way to avoid natural hazards becoming disasters is to strengthen and empower communities and individuals to manage the impacts of floods, severe storms, droughts and the like. This is particularly important for developing countries, which are more vulnerable to the vagaries of the weather and other natural hazards such as tsunamis, landslides, pandemics and so on, because they often have less developed infrastructure and monetary resources to protect residents and rebuild damaged property. Climate change adaptation and its corollary, disaster risk reduction, are considered to be building blocks for lessening risk and resilience enhancement. There is, therefore, a great need to understand the processes that operate at local and individual level within particular contexts in order for governments and relevant bodies such as emergency management organisations to be able to strengthen those that build resilience in the face of an impending hazard.

This introduction is organised into six sections. It begins from a discussion of the context – climate change – and flows on to conceptualisations of responses deemed to deal more effectively with the problems arising, specifically the increase in natural hazards. It concludes with the approach we believe is salient to understanding resilience to disasters. The approach uses Bronfenbrenner's bioecological theory as a conceptual framework, to model relevant influences upon a person or community entity so that interventions can be targeted to strengthen their resilience.

The context: climate change

Around the world most scientists, and the majority of governments, acknowledge that we are living in an age of climate change. Whether the cause of this

climate change is human activity – that is, whether it is anthropogenic, or part of a natural cycle – the fact remains that it is giving rise to an increased number of natural hazards. Floods, tornados, droughts, wildfires and hurricanes/typhoons/cyclones are experienced with more frequency globally. Some even contend that earthquakes and volcanic eruptions can be linked to climate change. This is because, they argue, an examination of the earth's past history, when the ice-age climate warmed naturally, shows evidence that earthquakes, tremors and even volcanic activity along pre-existing fault lines were triggered as a result of the climate change. The explanation is centred on the idea that the large ice sheets covering much of the planet were so heavy that the release of pressure when they melted caused the earth's crust to 'bounce back' (McGuire 2012). Many of these natural hazards are severe in intensity, such as the devastating category-5 Hurricane Katrina of 2005, category-4 Cyclone Yasi of 2011 and category-4 Typhoon Usagi of 2013. The number of Category-4 and 5 hurricanes worldwide nearly doubled between the early 1970s and the early 2000s. Moreover, both the duration of tropical cyclones and their strongest wind speeds have increased by about 50 per cent over the past 50 years. Of course there are also natural hazards that are not unanimously thought to be directly linked to climate change; for example, the magnitude-6.0 earthquake in the Emilia Romagna region of Italy, which resulted in more than €150 million in economic losses, and the 2011 6.3-magnitude Christchurch earthquake, which killed 185 people and cost New Zealand NZ$40 billion. According to UNISDR (United Nations Office for Disaster Risk Reduction), in the years 2000–2011, 1.1 million people were killed by natural hazards and 2.7 billion directly affected, with economic damage to the value of US$1.3 trillion reported globally. The year 2011 was recorded as the costliest year, with estimated disaster losses of US$380 billion. Using a new risk model UNISDR estimates that annual losses just from earthquakes and cyclonic winds will be in the range of US$180 billion annually this century (UNISDR 2013).

The human lives lost to such events, not to mention the economic costs from the hazards' impacts upon households, infrastructure and essential services, reflect the vulnerability of individuals and their communities to specific hazards. For example, vulnerability of individuals and communities in coastal zones depends on an ability to cope with the consequences of natural and socio-economic impacts of storms, rises in sea level or other phenomena induced by climate change. Socio-economic factors, such as disparities in income and asset distributions in a community, are critical in determining vulnerability and intimately linked with the risk exposure that individuals might experience as a result of a natural hazard.

To illustrate, a city located on the coast, such as Sydney, New Orleans or Manila, is more vulnerable to risks associated with sea-level rise than cities located further inland on higher ground. As a rule of thumb, a 0.1 m rise in sea level increases the frequency of flooding by a factor of about three. This effect is multiplicative, which means that an increase in mean sea level of 0.5 m will

increase the frequency of flooding by a factor of roughly 300. Therefore an event which presently only occurs on average once every 100 years (the '100-year return event') will happen several times a year after sea level has risen by 0.5 m (ACECRC 2012). It is clear that for communities such as Manila that are vulnerable to flooding, sea-level rise and the like, the level of vulnerability of a household will depend on a number of factors. The location of a dwelling, its construction, the household's resources and the individual and collective coping of those living in it will impact upon a household's vulnerability. It is also clear that the lens used to assess vulnerability will affect what is observed. For instance, different results will be gathered depending on whether one examines individual psychological vulnerability, ecological vulnerability (of a particular ecosystem, such as the Great Barrier Reef) or economic vulnerability as it impacts the livelihood of groups of residents or the very fabric of a whole town and its continued existence as a demographic and geographic entity, that is, whole-community vulnerability.

Even though there are clear differences between ecological and socio-economic vulnerability, it should be obvious from the foregoing that these are intrinsically connected. Individuals reside within specific ecological systems, which are in turn governed and managed by social organisations and institutions. The physical and ecological characteristics defining a community, whether it is situated up a mountainside in Austria or deep in the rainforest of Papua New Guinea, affect the social institutions, governance, culture and customs, both in terms of what is needed and what is available. Conversely the social and socio-economic milieu of the community invariably has an impact, direct or indirect, upon the ecological system in which it is embedded. Of course the complexity of a community invariably increases with the size of its population. Therefore to examine one without due consideration of the other will lead to an incomplete and possibly inaccurate assessment of vulnerability. Some examples will help to illustrate the point.

Natural hazards, extreme weather events or human activity, including over-fishing or coastal and industrial development, can result in changes in water quality, which in turn affect coastal habitats, leading to different composition of fish species. Such an ecological change can have social and economic ramifications, including conflicts over resources. For instance, climate change or a severe cyclone making landfall in particular Australian coastal areas may affect fish abundance and distribution. This can lead to conflicts between traditional Indigenous, recreational and commercial fishers over quotas, access and harvest of marine resources. Organisations and decision-makers negotiate and manage the emerging issues by seeking to agree upon fishing routines for all stakeholders to increase or at least avoid depleting the quality of life of stakeholders and to ensure the continued economic viability of the broader community, since fishing might be the main occupation of its members. This constitutes an important adaptive strategy for the future viability of the impacted ecological and socio-economic communities. Thus a disaster, namely the erosion of a whole vulnerable community, can be averted.

Clearly local contingencies are crucial considerations when examining vulnerabilities of people and places. Let's look at the case of Charleston, South Carolina. Like many coastal cities, its physical environment is critical in moulding the social fabric of the city. It has a flat topography with downtown Charleston comprising an eight-square-mile peninsula, although the city as a whole has grown to a total of 110 square miles. The population has also expanded in pace with the extension of city limits, and the many new settlers in the region are employed in the main industry of the city, tourism. The vast majority of these new residents have not experienced Charleston's natural hazards: hurricanes, floods, earthquakes and ice storms. Given that tourism is the city's main industry, what can be done to prevent a natural hazard from rendering the city a disaster zone? The large population and extent of the built environment present complex systems requiring multi-dimensional policies and negotiations between institutions and government bodies, as well as between local residents. Time and resources will be required to assess the potential vulnerability of groups of residents, their livelihoods, the built environment and essential infrastructure and services, in order to set up processes that will secure the safety and sustainability of the city.

Some lessons have been learnt from more extreme, devastating scenarios, which have been observed with regularity in developing and developed countries alike. One recalls the Indian Ocean tsunami of 2004, which led to over a quarter of a million deaths around the Indian Ocean. An example of a lesser tragedy, at least in terms of human lives lost, occurred in Australia in 2011: on 10 January 2011, the town of Grantham, Queensland, was inundated with a flash flood in which 12 of the town's 370 residents drowned. Grantham was one of more than 70 communities and 200,000 people in Queensland that were affected by flooding between December 2010 and January 2011. During this time the overall damage bill for Queensland was AU$2.38 billion (US$2.4 billion), with 35 deaths and more than three-quarters of the state declared a flood disaster zone. For Grantham, the flash flooding resulted in the unusual decision to relocate parts of the community of Grantham physically in March 2011. The Lockyer Valley Regional Council acquired a 377-hectare (932-acre) site to enable affected, vulnerable residents of Grantham to swap their properties voluntarily with equivalent-sized lots in a higher location less prone to flooding. To facilitate the unusual resettling process, planning regulations were set aside to streamline the relocation of a portion of the town. Grantham's response to the disaster, following the community's severe loss, ensures that damage will be less likely to reoccur with the same severity.

To avert or lessen the likelihood of a disaster following a natural hazard it is important to estimate and model how particular natural hazards might affect a community. Such thinking leads to assessments of vulnerability. A focus on the vulnerability of particular entities, whether at the level of individuals or on a much bigger city-wide scale, is designed to determine how much exposure and sensitivity to risk can be endured and how far disaster can be averted. Much effort has been devoted to disaster risk reduction.

Disaster risk reduction

Disaster Risk Reduction (DRR) aims to reduce the damage caused by natural hazards like earthquakes, floods, droughts and cyclones, through systematic and timely preparedness and prevention strategies. Disasters can follow natural hazards. A disaster's severity depends on the severity of a hazard's impact on communities and the environment. The scale of the impact in turn depends on the choices we, or previous stakeholders, have made for the way we live and conduct business and for our environment. These choices relate to how we conduct agricultural practices, produce our food, where and with what materials we build our homes, the sorts of infrastructure we give privilege to, the kind of government we elect, how our taxes are applied and even what we teach future generations, our children, in schools. Each decision and action has the potential to make us more vulnerable to natural hazards and prone to disasters – or more able to cope and withstand them.

Disaster risk reduction involves the reduction of disaster risks through systematic efforts to analyse and reduce the causes of disasters: reducing communities' and households' exposure to hazards; lessening the vulnerability of people and property; employing appropriate management of land and the environment; and improving preparedness and early warning systems for natural hazards. To this end, the United Nations Office for Disaster Risk Reduction (UNISDR) emphasises that there is no such thing as a 'natural' disaster, only natural hazards. It is now more than 10 years since the World Disaster Reduction Conference, held in Kobe, Hyogo, Japan in January 2005, led to the development of the Hyogo Framework for Action (HFA) 10-year plan to make the world safer from natural hazards. The HFA vision aimed to influence countries to develop policy, legislative and institutional frameworks for disaster risk reduction. These will enable countries to develop and track progress towards more disaster-safe communities through specific and measurable indicators. Indicators will be used to manage risks and to achieve widespread consensus for engagement in, and compliance with, disaster risk reduction measures across all sectors of society, in both developing and developed countries. A consequence of this drive to reduce disaster risk has been a focus on building resilience to disasters.

Resilience

Emergency management policy focuses on building resilience into global communities as an essential preamble to coping with climate change and concomitant disasters. Resilience, in particular community resilience, is becoming the most frequently used framework for enhancing community-level disaster preparedness, response and recovery, and for adaptation to climate change. The enhancement of disaster resilience has been the topic of recent high-level reports in the United States (National Academies 2012), the United Kingdom (UK Foresight 2012) and the United Nations (UNISDR 2012). This focus on resilience has emerged from observations that show some communities have

been able to respond and recover from disasters more quickly and effectively than others. These communities have been characterised as resilient. Key attributes of resilient communities include the ability to assess and manage risk, a preparedness to face threats and capacity to absorb shocks. Communities that exhibit strong social cohesion, where individuals are highly socially connected and have a strong sense of place, and communities containing networks that foster social connectivity with external agencies are more likely to be resilient (Boon 2014).

But what exactly is resilience? There have been reams of papers variously describing resilience over the past 60 or more years, with definitions that depend on the academic background of the theorist. Moreover, resilience has been understood in a different way depending on the level of analysis, for example, individual, community or ecological system. For instance, from an engineering perspective, a vitally important perspective when looking at strengthening neighbourhoods to withstand the impact of natural hazards, Uda and Kennedy (2015) consider three types of resilience:

- Engineering resilience, which looks at an entity's resilience as if it were a machine that can break in a crisis and would need to be fixed back to its original state.
- Ecological resilience, as applied to a biophysical ecosystem, is understood as the ability to reorganise and move into one of several possible states after a disturbance.
- Evolutionary resilience, which contends that there is no set ideal state or set of states for an entity to return or transition to, so an entity's resilience is its inherent capability to adapt and transform.

Others have described socio-ecological resilience, the capacity of ecosystems to sustain societal development and progress with essential ecosystem services (Berkes *et al.* 2003). More essentially, resilience describes the capacity of a person, community or ecosystem to persist in the face of shocks and disturbances without changing fundamental structures and functions. It is often associated with 'resistance', 'return to a previous state' or 'transformation', as well as combinations of these three terms (Dale *et al.* 2011). 'Resistance' refers to the capacity of the entity to resist shocks; 'return to a previous state' means that entity will return to its previous state after a disturbance; while 'transformation' refers to the capacity of individuals, organisations or the whole community to deal with challenges and persist, perhaps in an altered or novel state, despite adversity.

A debate about the range of definitions is still raging at this time and will likely continue. Most definitions however, tend to incorporate a stressor, the notion of adaptation and a return to pre-stressor levels of functioning, whether at individual or community level. We would stress that a return to pre-stressor functioning or a shift to a new state of adaptive functioning is the minimum expectation that is required for an individual or community to be considered resilient.

Given the interconnectedness and interdependence of human and socio-ecological systems, resilience-building strategies should address risks upon individuals, their livelihoods, food security and the natural environment as integral aspects. Consideration should be given to integrating disaster and climate risk management into enhanced social protection schemes and programmes that are resilient to shocks, while simultaneously improving standards for safety, health, capital assets and well-being. Similarly poverty-reduction initiatives such as employment-guarantee schemes, conditional cash transfers, micro-finance and insurance are key features of protection against disasters due to severe impacts from natural hazards. As a minimum, access to essential services and (unemployment) income, including protection from the risks of disasters, is now recognised as a universal human right that must be guaranteed to every individual (ILO 2011).

Implicit in disaster risk reduction is building resilience into critical infrastructure, such as transport conduits, schools and hospitals, not only to ensure continued basic social services but also to prevent long-term social and economic impacts that can result when, for example, education is disrupted by a disaster. With a focus to future generations, safe schools must include safe learning facilities, disaster preparedness and integration of disaster risk reduction into the curriculum. Comprehensive planning approaches that focus upon children and youth have also been known to mobilise communities. Children and youth have been instrumental in bringing together parents, local government and other institutions, and contributing to building whole-community resilience in many different countries (Back *et al.* 2009).

Of course, disaster risk reduction and resilience building are immense undertakings. Referring to efforts made in the United States, the National Research Council (NRC 2015) stresses the need for a multi-sectoral approach by national and local programmes to replace the prevailing ad-hoc and project-centred approach that is currently observed. The challenges of preparing resilient communities and increasing national resilience were documented in the United States report *Disaster Resilience: A National Imperative* (National Academies 2012). This report, sponsored by eight federal agencies and a community resilience organisation, extended to stakeholders beyond the Washington, DC governmental community. Its message was to emphasise the need for accurate information so that an understanding of national resilience could be embedded in communities across the United States. Among the findings issued by the committee was one underpinning the thrust of the rationale in this book, namely the need for a quantitative, numerical means of assessing resilience. This is so that the priority needs of communities are identified for interventions, to monitor incremental changes to resilience and to compare the cost benefits required for this undertaking. The overall aim of disaster risk reduction policy is to avert or minimise disasters, as illustrated in Figure 1.1.

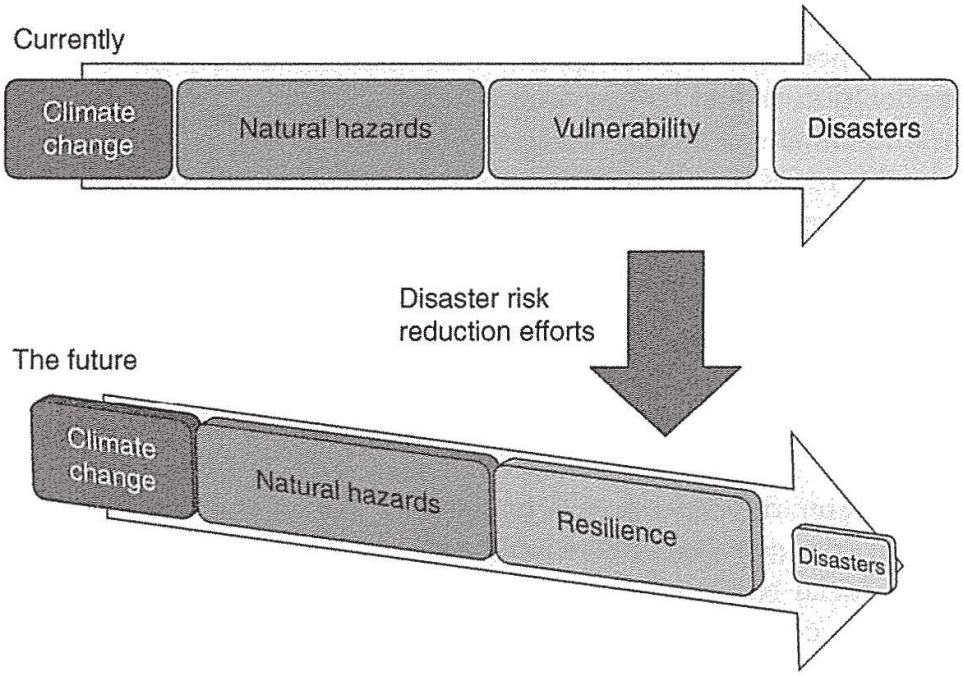

Figure 1.1 The aim of disaster risk reduction policy.

Challenges

Given that measuring, as well as defining, resilience is a challenge, measures and indicators to evaluate progress and incremental increases in resilience are deemed essential in tackling disaster risk reduction efforts. Moreover the data necessary to establish those measures are critical: communities need to define what resilience means for them and to develop and prioritise resilience investments. In the National Academies (2012) report, the committee reviewed the strengths and challenges of different frameworks for measuring resilience, and in so doing identified four essential facets of a reliable system to measure resilience. They noted that this system must include indicators or measures that assess:

- Vulnerable individuals, assessed via factors that capture special needs of individuals and groups, through minority and health status, mobility and socio-economic status indicators.
- Infrastructure, giving a snapshot of the ability of, for example, water and sewerage, transportation, power and communications to recover from hazardous events.
- Societal factors that enhance or limit a community's ability to recover, including variables underpinning social capital: education facilities, armed forces, governance, financial structures, cultural facilities and workforce.
- The built environment, indicating the ability of buildings to withstand the impact of natural hazards, assessing entities such as hospitals, local government offices, emergency response facilities, schools, businesses, bridges and roads.

The NRC described the United States as not having a consistent basis for measuring resilience that includes all of the above-mentioned dimensions, making it difficult for communities to monitor improvements or changes in their resilience. One of the recommendations from the 2012 report was that government entities (at federal, state and local levels) and professional organisations should partner to help develop a framework for communities to adapt to their circumstances and begin to track their progress towards increasing resilience.

It is beyond the scope of this book to document the efforts of individual countries to incorporate risk reduction approaches into their local and national policies. However, for those interested in investigating the progress made by a particular country the UNISDR website holds an extensive database with a large number of HFA (Hyogo Framework for Action) National Progress Reports, which are freely available. By way of a quick summary, 82 countries have begun the process of organising their disaster risk management by putting together disaster loss databases: 15 in Africa, 27 in the Americas, 26 in Asia-Pacific, 10 in Arab States and 4 in Europe (UNISDR 2015). National disaster loss databases systematically account, measure and analyse disaster losses associated with both hydro-meteorological and geological hazards. This is a crucial first step to generate the information necessary for risk estimation and to inform public investment in disaster risk reduction and climate change adaptation.

One of the key messages emerging from the foregoing discussion is the importance of finding and using a framework that is capable of organising and measuring facets of importance to socio-economic resilience: a resilience framework that could be used to help identify barriers to resilience, prioritise actions and measure progress aligned with disaster risk reduction goals and their associated monitoring processes. Such a framework, one moreover which has been tested and can be applied to diverse settings and conditions, is the one that was originally designed as a way to study and understand the range of influences that act upon the development of children: Uri Bronfenbrenner's bioecological systems theory.

Bronfenbrenner's bioecological systems theory

Uri Bronfenbrenner was a Russian-born American developmental psychologist who developed the ecological systems theory of child development. His work, which was instrumental in the establishment of the Head Start Program in 1965 in the USA, was highly influential in changing the perspective of developmental psychology because it acknowledged the importance of environmental and societal influences on child development. Bronfenbrenner's ecological systems theory has been widely used by psychologists interested in understanding individuals in context. A search in Google Scholar reveals that *The Ecology of Human Development* (Bronfenbrenner 1979) has been cited over 15,000 times. Bronfenbrenner is credited with focusing the attention of developmental scientists to the contextual variation that is observed in human development. He was instrumental in helping to move developmental psychology from what

he derisively referred to as 'the science of the strange behaviour of children in strange situations with strange adults for the briefest possible periods of time' (Bronfenbrenner 1977: 513) to more 'ecologically valid' studies of developing individuals in their natural environment. The theory has been used to understand how particular contexts or settings influence the emergence of a range of attributes. Research based on his theory have been successfully used to explain a range of phenomena, including adolescent motivation and academic outcomes (e.g. Boon 2006), developmental risk and protective factors for substance use (e.g. Szapocznik and Coatsworth 1999), youth activity engagement (e.g. Rose-Krasnor 2009), family influence on gender development (e.g. McHale *et al.* 2003) and more recently the development of disaster resilience (Boon *et al.* 2012).

Bronfenbrenner theorised that developing children are subject to a range of effects arising from the processes and events that occur in the consecutive layers comprising their social and environmental milieu, which he visualised as a set of nested Russian dolls (Bronfenbrenner 1979: 3). Figure 1.2 shows the most usual conceptualisation of the theory as originally posited by Bronfenbrenner. He viewed the developmental context as being the sum of effects that take place in five sequentially nested spaces. Development refers to stability and change in the characteristics of human beings over the life course and across generations. The inner circle – the microsystem – describes the settings in which the developing individual has direct, face-to-face interactions with significant people, such as family, friends, co-workers and teachers. This is where a person's time is spent, where daily life takes place and where development and learning occur. There are cross-relationships among these small settings – parents talk to peers, or teachers, for example – and these interconnections form a network called the mesosystem (Bronfenbrenner 1979: 25). Beyond this is an outer circle of people and organisations that indirectly influence a person's development, such as the parents' employers, health care workers and the media; this is called the exosystem (Bronfenbrenner 1979: 25). Bronfenbrenner also described a macrosystem (the prevailing cultural and economic conditions of a society) and a chronosystem (the element of time, which impacts upon changes and shifts upon each system; see Figure 1.2). Table 1.1 outlines the various systems and their descriptions extracted from Bronfenbrenner's original conceptualisation.

A range of studies have used this theory to identify contextual predictors or processes that emanate from sources outside of the individual and impact upon his or her development. In other words, research has sought to determine the environmental, social and physical factors that moderate and modulate a person's development, learning and behaviours. For example, Evans, Chen, Miller and Seeman (Evans *et al.* 2012) from Cornell University have shown through longitudinal studies in the USA that children who have been exposed to chronic stress and poverty display significant differences from typical children in their emotional regulation; these persist into adulthood and are found to be hard wired in their brain anatomy as adults. Countless other longitudinal studies by the same group of researchers have shown that social determinants translate

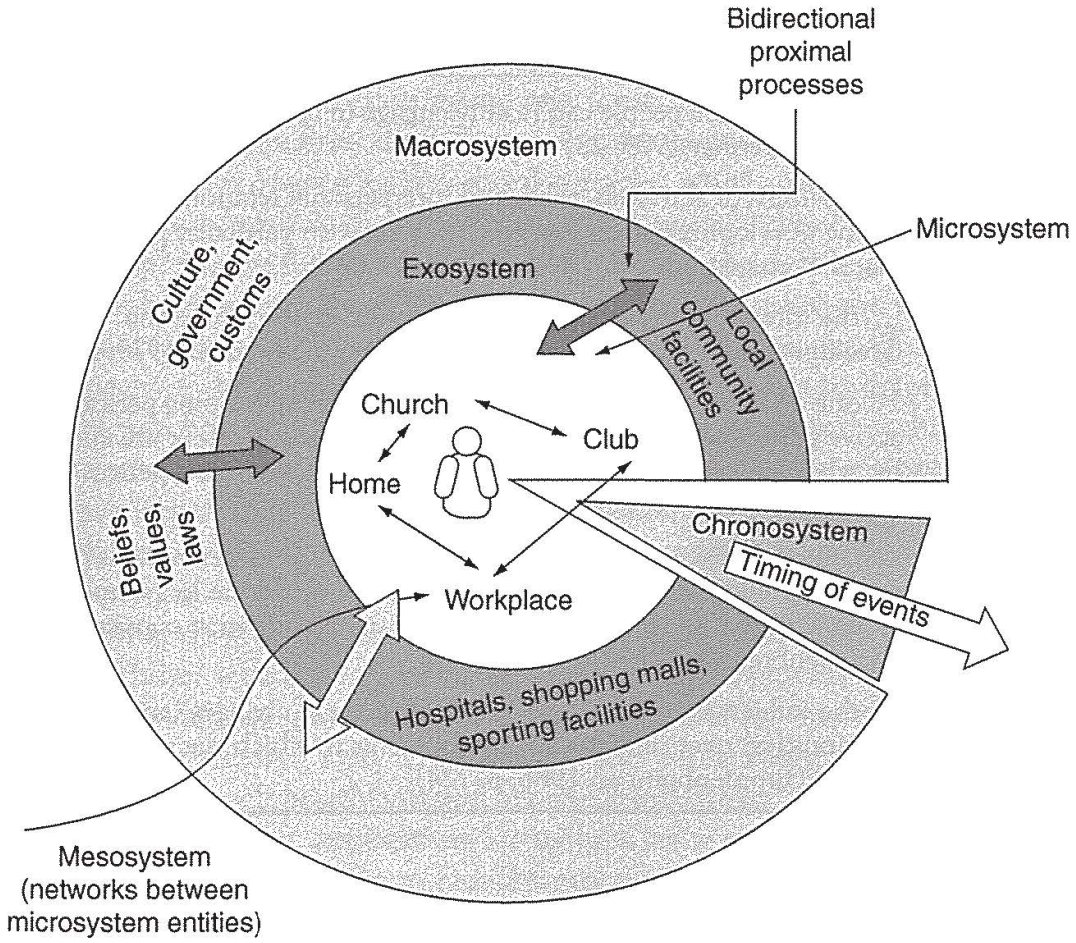

Figure 1.2 Bronfenbrenner's ecological systems theory.

into outcomes such as lower academic achievement and material success as well as higher predisposition to illness and obesity.

Bronfenbrenner believed behaviour and learning to be the product of the individual's way of perceiving certain contextual factors and responding to them. The basis of this theory is succinctly captured in the following extract:

> Throughout the life course, human development takes place through processes of progressively more complex reciprocal interaction between an active, evolving biopsychological human organism and the persons, objects, and symbols in its immediate external environment. To be effective, the interaction must occur on a fairly regular basis over extended periods of time. Such enduring forms of interaction on the immediate environment are referred to as proximal processes.
>
> (Bronfenbrenner and Morris 1998: 996)

In relation to the use of the theory, Bronfenbrenner pointed out three essential considerations. First, ecological systems must be understood interdependently,

Table 1.1 Descriptions of Bronfenbrenner's ecological systems

Construct	*Descriptor*
Setting	'...a place where people can readily engage in face-to-face interaction.' (Bronfenbrenner 1979: 22)
Microsystem	'...a pattern of activities, roles, and interpersonal relations experienced by the developing person in a given setting with particular physical and material characteristics.' (Bronfenbrenner 1979: 22)
Mesosystem	'...the interrelations among two or more settings in which the developing person actively participates.' (Bronfenbrenner 1979: 25)
Exosystem	'...one or more settings that do not involve the developing person as an active participant, but in which events occur that affect, or are affected by, what happens in the setting containing the developing person.' (Bronfenbrenner 1979: 25)
Macrosystem	'...consistencies, in the form and content of lower-order systems that exist, or could exist, at the level of subculture or culture as a whole, along with any belief systems or ideology underlying such consistencies.' (Bronfenbrenner 1979: 26)
Chronosystem	'...the influence on the person's development of changes (and continuities) over time in the environments in which the person is living.' (Bronfenbrenner, 1986, p. 724)

such that what happens or fails to happen in any given environment depends to a large extent on events and relationships in other related environments. This means that researchers must consider the interaction of systems in which people participate, not only the influence of the developing individual's immediate setting. Second, development occurs via processes, or modes of interaction between people. Bronfenbrenner therefore argued that researchers conducting ecological research must consider more than one person in the setting of focus. Third, ecological environments are phenomenologically constructed and understood: they orient the developing person's actions and interactions. These ideas are observable and can be illustrated by an example that is pertinent to the discussion of disaster risk reduction. Emergency managers routinely send out warnings, communicated by radio, TV and the like, when a cyclone approaches the coast in Australia. The warnings are interpreted and acted upon in different ways, however, depending on whether individuals perceive a genuine danger and threat to self and property. It has been shown that some individuals who have lived through a natural hazard, such as flood or cyclone, do not heed emergency warnings to begin preparing themselves and their property for disaster impact, having instead a 'wait and see' attitude (Boon *et al.* 2012). Conversely, those who have never experienced a hazard, such as a fire or flood, might have a different response, such as panic or anxiety, and might be more likely to begin preparations to protect their property or even flee from the vulnerable location if they are able. The environment should thus be considered as it is perceived

and understood by the individual. From a methodological perspective, a phenomenological analysis examines how each participant perceives the setting and the various elements contained within it. A critical aspect of the theory is therefore the concept of experienced relations: 'The term experienced is used to indicate that the scientifically relevant features of any environment include not only its objective properties but also the way in which these properties are perceived by the persons in that environment' (Bronfenbrenner 1979: 22).

An emphasis on the phenomenological view of the developing person means that people's perceptions of their environments constitute the most important influences upon their development, learning and behaviours. This implies that the aspects of the environment that have the most power to shape the an individual's psychological growth are those that have meaning to him or her in given situations. The theory also strongly suggests that relationships within contexts are important for learning and development, particularly for the development of resilience, as will be shown in forthcoming chapters. Realising the broad potential of the theory, Bronfenbrenner advocated specific research models or approaches for the study of developmental outcomes (Bronfenbrenner 1986). These, which he referred to as the person, process context and time (PPCT) models, he proposed to be used as a guide for any research using the bioecological theory. They are depicted and summarised in Figure 1.3, with illustrations of each possible design approach following.

To illustrate their application let us look at a question: how might extra-familiar conditions affect intra-familiar processes that lead to disaster resilience? Research to answer this question might take one of three possible approaches:

- Mesosystemic: for example, examining the influences of family and neighbours upon a person's disaster resilience through emotional and physical support strategies offered (e.g. Boon 2013).
- Exosystemic: for example, the effects of emergency management warnings upon preparedness and the subsequent disaster resilience that ensues from safely navigating through a hazard (e.g. Boon 2014b).

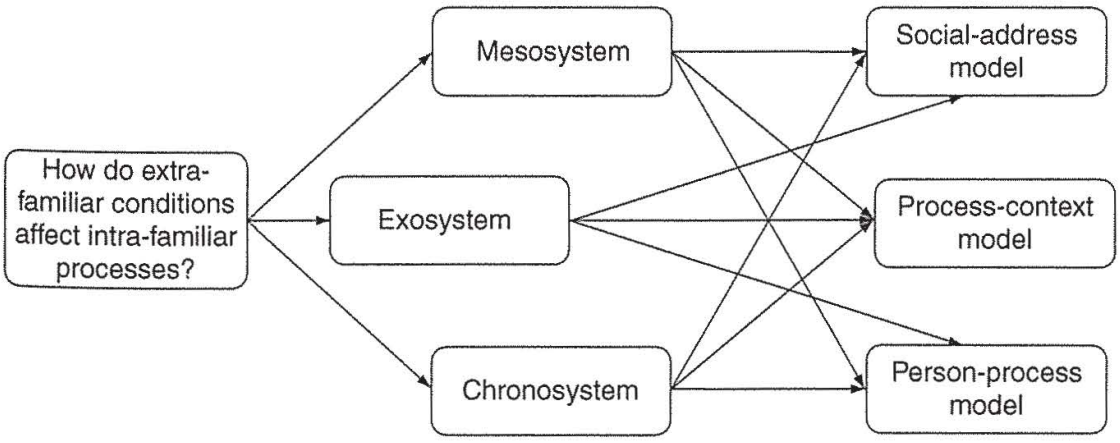

Figure 1.3 Research models conceptualised by Bronfenbrenner (1986).

- Chronosystemic: for example, the effects of environmental changes, such as climate change, and residential mobility or stability, in relation to changes in individuals' disaster resilience in context over time (Boon 2014a).

Further, in selecting a mesosystem, exosystem or chronosystem research approach to clarify the influences upon an individual's disaster resilience, an investigation might focus upon one of the three PPCT models to answer the research question. Specifically, using the mesosystem as the basis of the research, one could look at:

1 The social determinants of the context, a social address model: this might examine how social class, poverty or ethnicity moderates the amount of physical support that is offered.
2 The process context model might examine *qualitatively* the types of emotional and physical support processes that are proffered by family and neighbours within different socio-economic contexts.
3 A person process context model would focus on the moderation that individuals' personal characteristics have upon the types of emotional and physical support that are offered by family and neighbours within different socio-economic contexts.

Of course, Bronfenbrenner realised early on that the discovery of a relationship between social class and a particular expression of behaviour was a meaningless one until the sociological variable was reduced to psychological terms. For him, it was essential to examine thoroughly the intervening processes through which environmental influences exert their effects. Validation of this notion was obtained from evidence that children's behaviours were influenced more by what parents did in their interactions with them than by the parents' socio-economic status, in terms of income, education or profession. In other words, interpersonal processes were the key determinants of outcomes. This was the rationale that drove Bronfenbrenner's subsequent reformulations of his original ecological systems theory towards the bioecological theory (Bronfenbrenner 1986).

This later bioecological systems theory stressed the role played by the individual, the impact of time and, most important of all, proximal processes. Crucial to the theory was Bronfenbrenner's emphatic assertion that stability and change occurs within a phenomenological perspective. Such a perspective considers not only the objective properties of the setting in which a person is acting and interacting but also its subjective properties, as experienced by the person (Bronfenbrenner and Evans 2000). Bioecological theory in its current form specifies that researchers should study the settings in which a developing individual spends time and his or her relations with others in those settings, as well as the personal characteristics of the individual (and those of the people with whom he or she typically interacts). A study of the individual's development over time must be teamed with due consideration of the historical time in which the individual lives, as well as the mechanisms that drive development (proximal processes). These later considerations by Bronfenbrenner echo his early recognition of the role of social

interactions and networks in shaping development (Bronfenbrenner 1945); in fact he was a pioneer in the earliest days of social network research.

Bronfenbrenner's theory is an attractive one for research around disaster risk reduction and community resilience building because it is expansive, yet focused: one eye is trained on the complex layers of household, family and community relationships, and the other is sharply focused on individual learning and behaviour development. Through his bioecological theory, Bronfenbrenner accounts for the biological as well as environmental influences upon a person. He stressed that learning and subsequent behavioural profiles and belief systems are moulded by and develop within a complex system of interrelationships that are affected by differing aspects of the surrounding environment and biological dispositions of each person (Bronfenbrenner and Evans 2000).

Not only is this theory useful at the level of the individual but the same lens can also be applied to whole communities to examine their vulnerability and assess areas of resilience. Because of the intrinsic bidirectional effects inherent in the theory, whereby the individuals are effectively moderating their social and physical environment as the environment impacts upon them, it is possible to make accurate estimates for risks of natural hazards. At the same time it is possible to devise interventions targeted appropriately to help build stronger, more resilient communities. The chapters that follow will further illustrate applications of this theory to disaster prevention and social resilience.

Summary

Climate change is moderating the broader environmental conditions globally, and this has led to a focus of attention on the projected increase in natural hazards. These hazard events have led to socio-ecological disasters, but this is not an inevitable corollary of a natural hazard. To prepare for the impacts of hazard events, governments and emergency managers have set in motion a disaster risk policy that aims to reduce risk and community vulnerability and increase social and physical resilience.

Resilience, in its various and diverse definitions, is considered to be an adaptive state for individuals and communities to aim for when threatened with the prospect of impending hazard events.

In order to operationalise this policy, communities of all sizes need to be examined and assessed for risks and potential vulnerabilities to the specific natural hazards that could bear upon them.

One effective way to structure such an examination of communities and other social entities is through the use of a framework based upon Uri Bronfenbrenner's bioecological theory. This framework or theoretical lens permits an accurate examination of individuals, as well as larger entities such as communities and cities, both in terms of their organisation and the processes that take place within and between them. The theory offers a range of research designs that can be employed to measure the development of resilience, ranging from the more static and descriptive to more dynamic procedural applications.

References

ACECRC (Antarctic Climate and Ecosystems Cooperative and Research Centre) 2012, 'Report Card: Sea-level Rise 2012'. ACECRC, Hobart, Tasmania.

Back, E., Cameron, C. and Tanner, T.M. 2009, 'Children and Disaster Risk Reduction: Taking Stock and Moving Forward'. Children in a Changing Climate Report, Institute of Development Studies, Brighton, UK, 44 pp.

Berkes, F., Colding, J. and Folke, C. 2003, Introduction, in F. Berkes, J. Colding and C. Folke (eds), *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge University Press, Cambridge, pp. 1–32.

Boon, H.J. 2006, 'Students At-Risk: A Bioecological Investigation'. PhD thesis, James Cook University, Queensland, Australia.

Boon, H.J. 2013, 'Preparedness and Vulnerability: An Issue of Equity in Australian Disaster Situations', *Australian Journal of Emergency Management*, vol. 28, no. 3, p. 12.

Boon, H.J. 2014a, 'Disaster Resilience in a Flood-Impacted Rural Australian Town', *Natural Hazards*, vol. 71, no. 1, pp. 683–701.

Boon, H.J. 2014b, 'Investigating Rural Community Communication for Flood and Bushfire Preparedness', *Australian Journal of Emergency Management*, vol. 29, no. 4, pp. 17–25.

Boon, H.J., Millar, J., Lake, D., Cottrell, A. and King, D. 2012, *Recovery from Disaster: Resilience, Adaptability and Perceptions of Climate Change*. National Climate Change Adaptation Research Facility, Queensland.

Bronfenbrenner, U. 1945, *The Measurement of Sociometric Status, Structure, and Development*. Beacon House, New York.

Bronfenbrenner, U. 1977, 'Toward an Experimental Ecology of Human Development', *American Psychologist*, vol. 32, pp. 513–531.

Bronfenbrenner, U. 1979, *The Ecology of Human Development: Experiments by Nature and Design*. Harvard University Press, Cambridge, MA.

Bronfenbrenner, U. 1986, 'Ecology of the Family as a Context for Human Development: Research Perspectives', *Developmental Psychology*, vol. 22, pp. 723–742.

Bronfenbrenner, U. and Evans, G.W. 2000, 'Developmental Science in the 21st Century: Emerging Theoretical Models, Research Designs, and Empirical Findings', *Social Development*, vol. 9, pp. 115–125.

Bronfenbrenner, U. and Morris, P.A. 1998, 'The Ecology of Developmental Processes', in R.M. Lerner (ed.), *Handbook of Child Psychology* (fifth edn, vol. 1), pp. 993–1028. Wiley, New York.

Dale, A., Vella, K., Cottrell, A., Pert, P., Stephenson, B., Boon, H., King, D., Whitehouse, H., Hill, R., Babacan, H. and Gooch, M. 2011, 'Conceptualising, Evaluating and Reporting Social Resilience in Vulnerable Regional and Remote Communities Facing Climate Change in Tropical Queensland'. MTSRF Transition Project Final Report, Marine and Tropical Sciences Research Facility, Cairns, Australia.

Evans, G.W., Chen, E., Miller, G.E. and Seeman, T.E. 2012, 'How Poverty Gets Under the Skin: A Life-Course Perspective', in V. Maholmes and R. King (eds), *The Oxford Handbook of Poverty and Child Development*. Oxford University Press, New York, pp. 13–36.

Foresight 2012, 'Foresight Reducing Risks of Future Disasters: Priorities for Decision Makers, Final Project Report'. Government Office for Science, London.

ILO (International Labour Organization) 2011, 'Social Protection Floor for Fair and Inclusive Globalization'. ILO, United Nations.

McGuire, B. 2012, *Waking the Giant: How a changing Climate Triggers Earthquakes, Tsunamis, and Volcanoes*. Oxford University Press, Oxford.

McHale, S.M., Crouter, A.C. and Whiteman, S.D. 2003, 'The Family Contexts of Gender Development in Childhood and Adolescence', *Social Development*, vol. 12, pp. 125–148.

The National Academies 2012, *Disaster Resilience: A National Imperative*. The National Academies Press, Washington, DC.

NRC (National Research Council) 2015, 'Developing a Framework for Measuring Community Resilience: Summary of a Workshop'. National Academies of Sciences, Engineering, Medicine, Washington, DC.

Rose-Krasnor, L. 2009, 'Future Directions in Youth Involvement Research', *Social Development*, vol. 18, pp. 497–509. doi: 10.1111/j.1467-9507.2008.00506.x.

Szapocznik, J. and Coatsworth, J.D. 1999, 'An Eco-Developmental Framework for Organizing the Influences on Drug Abuse: A Developmental Model of Risk and Protection', in D. Meyer and C.R. Hartel (eds), *Drug Abuse: Origins and Interventions*. American Psychological Association, Washington, DC, pp. 331–366.

Uda, M. and Kennedy, C. 2015, 'A Framework for Analysing Neighbourhood Resilience'. Proceedings of the Institution of Civil Engineers, ICE Publishing, London. http://dx.doi.org/10.1680/udap. 14.00028.

UNISDR 2012, 'Making Cities Resilient Report'. United Nations Office for Disaster Risk Reduction, Geneva.

UNISDR 2013, 'Global Assessment Report on Disaster Risk Reduction'. United Nations Office for Disaster Risk Reduction, Geneva.

UNISDR 2014, Annual Report. United Nations Office for Disaster Risk Reduction, Geneva.

UNISDR 2015, 'Global Assessment Report on Disaster Risk Reduction'. United Nations Office for Disaster Risk Reduction, Geneva.